Issued November 4, 1909.

U. S. DEPARTMENT OF AGRICULTURE,

FOREST SERVICE—Circular 168.

GIFFORD PINCHOT, Forester.

COMMERCIAL IMPORTANCE OF THE WHITE MOUNTAIN FORESTS.

BY

PHILIP W. AYRES,

FORESTER OF THE SOCIETY FOR THE PROTECTION OF NEW HAMPSHIRE FORESTS.

8053—Cir. 168—09——1

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1909

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COMMERCIAL IMPORTANCE OF THE WHITE MOUNTAIN FORESTS.

The White Mountain region is naturally a forest country. The rocky soil, steep slopes, and high elevations prevent the use of the land for agriculture, except in a few favored places. The forests that cover the mountains are partly primeval, partly culled, and in places cut clean by the ax. In many places they have been injured severely by fire. Their resources are of great and far-reaching value, for their use extends not only throughout New England, but also, in the form of news paper manufactured from spruce and in other manufactured products, throughout the entire country.

The persistent widespread advance in the price of timber products has been felt throughout the land. It has already affected directly all forms of business that deal primarily with wood, such as the building trades, the woodworking factories, ties for railway construction and repair, and mine props, and indirectly other business, such as farming, in which the cost of a barn or a wagon is much greater than heretofore. It is confidently asserted that "the rise in the price of lumber which marks the opening of the present century is the beginning of a greater and more rapid rise which is to come, and the suffering which will result from the progressive failure of our timber was but faintly foreshadowed by the recent temporary scarcity of coal." There has been reckless waste of the vast forest wealth of the nation, which is still going on, but changes for the better are being made in important directions. The more thoughtful lumbermen see the issue clearly and have begun to treat the forest more conservatively. Some have bought up large tracts against the coming scarcity. The Government has established National Forests in the West, which will in part meet the ever-growing demand for timber in that section of the country.

The even flow of water from mountain forests is of utmost importance. Commerce and manufacture depend upon it. The White Mountains form the great watershed of New England. Five of the most important rivers of New England, each having remarkable water power, take their rise in the heights of northern New Hampshire and in portions of two adjoining counties in Maine. These rivers are the Connecticut, the Merrimac, the Saco, the Androscoggin, and the Kennebec. The growth of many of the most progressive

and populous cities in New England has depended upon the development of water powers on these rivers, so that it may be said that the financial well-being of New England hinges upon them. Moreover, each summer the mountain forests afford rest and recreation to many thousands of people from all parts of the country.

Fire and the ax have made destructive inroads upon the White Mountain forests, and have profoundly changed their natural conditions.

These several considerations lead to a study of the mountain forests as sources of timber supply for New England and the northeastern United States, and of their value in the protection of stream flow. This publication treats specifically of the White Mountain forests under the following heads: (1) As a source of timber supply; (2) their protection from fire; (3) as an influence on water power; (4) as an influence on navigation; (5) as a place of health and recreation.

THE TIMBER SUPPLY.

The rise in the price of timber has been general throughout the country and continuous through a period of years. Table 1 shows the increase in the prices of raw material in each of the New England States from 1900 to 1905, and gives the average increase. It also shows the same facts in groups of lumber States in different parts of the country and the average increase in the United States.

TABLE 1.—*Stumpage and log values by States,[a] 1900 and 1905.*

State.	Standing timber (value per M board feet).			Saw logs (value per M board feet).		
	1900.	1905.	Increase.	1900.	1905.	Increase.
			Per cent.			*Per cent.*
Maine	$2.52	$3.70	46.8	$8.15	$9.66	18.5
New Hampshire	2.68	4.28	59.7	6.96	8.79	26.3
Vermont	2.09	3.93	88.0	5.80	10.00	72.4
Massachusetts	2.64	4.19	58.7	9.49	8.94	[b] 5.8
Rhode Island	3.02	4.12	36.4	7.15	6.86	[b] 4.0
Connecticut	2.90	4.15	43.1	7.88	9.32	18.3
Average in New England	2.65	4.06	53.2	7.57	8.93	18.0
Average in 4 Middle Atlantic States[c]	3.38	4.39	30.0	6.89	9.71	40.8
Average in 3 Lake States[d]	3.32	4.19	26.2	7.63	9.95	30.4
Average in 3 Pacific States[e]	.87	1.14	31.0	4.74	6.20	30.8
Average in 8 Southern States[f]	1.94	2.74	41.2	6.02	7.87	30.7
Average in United States	2.18	2.59	18.8	6.28	7.51	19.6

[a] Derived from Table 8 of Bulletin 77, Bureau of the Census, U. S. Department of Commerce and Labor.
[b] Decrease.
[c] New York, New Jersey, Pennsylvania, Delaware.
[d] Michigan, Wisconsin, Minnesota.
[e] Washington, Oregon, California.
[f] Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Kentucky, Tennessee.

The rise in price of standing timber during these five years has been greatest in Vermont, though the price there in 1900 was the lowest in New England. The two next greatest increases are in New Hampshire and Massachusetts. The rise in New England is greater than in any of the other groups of States (although in the Southern

Appalachian States it is very large), and is between three and four times as large as the average for the entire country.

CAUSES OF THE ADVANCE IN PRICE.

The causes of the advance in price, which are both general and local, depend on these facts: In those States that formerly led all others in the production of lumber the supply is either exhausted, and there are practically no saw logs available for the mills, or the annual cut has become relatively much less important, as in New York, Pennsylvania, and the Lake States. These changes are indicated in the accompanying tabulated list (Table 2):

TABLE 2.—*Relative rank of the eight States leading in the production of lumber since 1850.*

1850.	1860.	1870.	1880.	1890.	1900.	1907.
New York.	Penn'lv'nia.	Michigan.	Michigan.	Michigan.	Wisconsin.	Wash'ngt'n.
Penn'lv'nia.	New York.	Penn'lv'nia.	Penn'lv'nia.	Wisconsin.	Michigan.	Louisiana.
Maine.	Michigan.	New York.	Wisconsin.	Penn'lv'nia.	Minnesota.	Texas.
Ohio.	Maine.	Wisconsin.	New York.	Minnesota.	Penn'lv'nia.	Mississippi.
Indiana.	Ohio.	Indiana.	Indiana.	Indiana.	Wash'ngt'n.	Wisconsin.
Michigan.	Indiana.	Maine.	Ohio.	Wash'ngt'n.	Arkansas.	Arkansas.
Mas'chusetts.	Wisconsin.	Ohio.	Maine.	New York.	Ohio.	Michigan.
Illinois.	California.	Missouri.	Minnesota.	Ohio.	Indiana.	Penn'lv'nia.

There has been a general realignment, due to partial exhaustion in the older States. New York, which led in the cut of 1850, disappeared from the table of the eight leading States in 1900. Pennsylvania, which was first in 1860, fell to eighth in 1907, a period of forty-seven years. Michigan, which held sixth place, advanced to first for two decades and has now declined to seventh (1907). Michigan and Wisconsin, which together held the lead for forty years, have now been surpassed by Washington, Louisiana, Texas, and Mississippi. How long will the supply of the Pacific States and the Southwest meet the now enormous and ever-growing demand? Nearly all of the States shown in the preceding diagram are primarily agricultural, and the land is used for farming after the forests are cut. But in the mountain regions of the Appalachian system agriculture is necessarily restricted and a forest crop returns. In the proper management of this new crop lies the hope of the future. The demand of the country has turned back already upon these mountain regions, and in New England, where the population is dense and the market excellent, the advance in timber prices has been sharpest. The purchase of extensive tracts for future use by large companies has further restricted the supply, particularly in New Hampshire. To this nonagricultural and natural forest land the country must turn more and more in future. Thirty-seven per cent of the State of New Hampshire, or about 3,300 square miles, has never been cleared for farms. There are besides nearly 3,000 additional square miles (1,760,000 acres) which were

taxed as improved lands in 1850, but had reverted to unimproved lands by 1900.[a] These are the "abandoned farms."

CLASSIFICATION OF LAND IN NORTHERN NEW HAMPSHIRE.

Tables 3 and 4 show the classification of land in northern New Hampshire and cover the White Mountain region. The area examined was 1,951,977 acres.[b]

TABLE 3.—*Area of northern New Hampshire, land and water.*[c]

	Acres.
Virgin merchantable forest	200,000
Cut-over or culled land	1,363,711
Barren and waste land	120,495
Total forest land	1,684,206
Agricultural land	244,036
Water	23,735
Total	1,951,977

Table 3 shows that virgin forest forms only about 12 per cent of the total forest area.

TABLE 4.—*Approximate ownership of forest lands in northern New Hampshire.*

	Acres.
Large lumber and pulp companies	900,000
Hotel companies	28,000
Small holders of forest land	756,000
Agricultural land, small holdings	244,000
Total	1,928,000

The publication from which Tables 3 and 4 are derived contains further detailed information which proves that the agricultural land is but little more than one-tenth of the area of northern New Hampshire; that nearly 150,000 acres are in waste or in a barren condition, or covered with water; that nearly 85,000 acres were burned over in the "big fire year" of 1903; that the stand of conifers is estimated to contain 4,764,000,000 feet b. m.; that the areas occupied by these conifers, such as spruce, pine, and balsam, are five times as large as the hardwood areas, taking the northern part of the State as a whole.

TREE SPECIES.

The tree species most abundant in the White Mountain forests may be considered in two groups, conifers and the hardwoods. Of the conifers red spruce is the most important tree, outranking any other in quantity and value. It is seldom found below 1,200 feet above sea level except in swamps. At lower altitudes it gives place to

[a] Twelfth Census Bulletin, New Hampshire.

[b] Forest Service Bulletin 55, "Forest Conditions of Northern New Hampshire," by Alfred K. Chittenden, 1905.

[c] Tables 3 and 4 are from Forest Service Bulletin 55.

white pine, yet since most of the forest region under consideration is about 1,200 feet, pine may be left out of consideration. Spruce is abundant everywhere and extends to timber line. Balsam fir is found usually in mixture, forming from 1 to 20 per cent of the stand. Unless otherwise stated, spruce in this report includes both spruce and fir, as both are used for paper pulp, and to a less extent for saw logs, and the product is sold as spruce. A belt of hemlock extends around the mountains on the lower slopes, and at the north white cedar is found in fair quantity. Of the hardwoods yellow and paper birch are the most abundant and valuable, followed by maple, beech, and aspen or popple.

SPRUCE.

Vast areas of spruce once spread over the mountains in unbroken stands, but uncut areas are now somewhat rare. Because of its shallow root system it finds sustenance on the thin soils of swamps and on high slopes. The best growth appears in mixture with hardwoods at elevations from 1,200 to 2,000 feet. In such places there is generally left a sufficient forest cover when the spruce is removed. Above 2,000 feet it occurs in almost pure stands up to 3,500 feet, which is the limit of its commercial range. On these higher slopes its removal is usually followed sooner or later by disastrous fires, which in turn are followed by erosion and rapid run-off of water into the streams. Uncut, the spruce forest forms a characteristic feature in the mountain landscape.

Spruce wood has many uses. It is used in the manufacture of paper, especially news paper, and of that cut in the northeastern States almost two-thirds is used for this purpose, although in northern New Hampshire a smaller proportion, about one-half, is so used.

A few of the best butt logs are used in the manufacture of piano sounding boards and cases. One plant that employs 350 men is devoted chiefly to this business. There are a few mills that saw for this purpose only.

Spruce is also used in the manufacture of lumber, both dimension and finishing materials. With the disappearance of old-growth white pine spruce became a staple lumber product in the Boston and other New England markets, where it still holds a leading place. It is used for flooring, ceiling, and clapboards, for shingles and laths, boxing materials, and pump tubing.

GROWTH OF THE PAPER AND PULP BUSINESS.

The phenomenal growth in the manufacture of paper from spruce pulp during the five years between 1900 and 1905 is indicated in Table 5. The figures for fifteen years since 1890 are included for New Hampshire in order to show the extraordinary development from small beginnings since the industry began.

TABLE 5.—*The paper and pulp industry in New England.*[a]

State.	Year.	Number of mills.	Average number of wage-earners.	Total wages.	Total capital.	Value of product.
New Hampshire	1890	15	520	$220,122	$1,221,491	$1,282,022
	1900	19	2,391	1,036,856	8,163,081	7,244,733
	1905	25	2,522	1,315,310	14,041,014	8,930,291
Maine	1900	35	4,851	2,162,972	17,473,160	13,223,275
	1905	37	7,574	4,052,919	41,273,915	22,951,124
Vermont	1900	27	1,216	571,018	4,853,806	3,384,773
	1905	28	1,280	616,735	5,628,676	3,831,448
Massachusetts	1900	93	9,061	3,938,400	26,692,922	22,141,461
	1905	87	17,705	5,587,862	41,073,769	32,012,247
Connecticut	1900	49	1,425	633,413	3,968,152	3,565,021
	1905	50	1,750	843,333	5,892,684	5,639,147
Totals	1900	223	18,944	8,342,659	60,931,121	49,559,263
	1905	227	30,831	12,416,159	107,910,058	73,364,259

[a] Table compiled from U. S. Census reports. It includes paper mills with pulp mills; there are much fewer mills that produce pulp alone—in New Hampshire only four.

The capital invested in this industry in New Hampshire has increased in fifteen years at the rate of nearly $1,000,000 a year and the value of the product half a million. In Maine the increase of capital has been from $17,000,000 to $41,000,000 in five years, and the value of the product from $13,000,000 to $22,000,000. The number of wage-earners in 1905 was more than 30,000. It is significant that in Massachusetts [a] and Connecticut, which are not large spruce-producing States, the paper industry is well developed. This shows the interstate relations of the industry. The $41,000,000 invested in Massachusetts and the nearly $6,000,000 in Connecticut depend for supplies of pulp upon the forests of northern New England. The total investment in New England in 1905 was $107,910,058.

THE USE OF SPRUCE FOR LUMBER.

The number of sawmills cutting spruce for lumber and the amount cut in the New England States are given in Table 6.

TABLE 6.—*Mills cutting spruce, 1907.*

State.[b]	Sawmills.	Amount cut.
	Number.	*M board feet.*
Maine	596	528,013
New Hampshire	279	203,092
Vermont	457	156,354
Massachusetts	101	43,141
Total	1,433	930,600

[a] Massachusetts produces some spruce in Berkshire County, 26,068,000 feet in 1906.
[b] Mills in Connecticut are included in "All other States" by the Census and could not be segregated.

The mills are located chiefly in northern New England, where spruce grows. In addition to that used to supply local demands, a large part of the product is shipped to Boston and thence redistributed. From Boston there is a coastwise trade to New York, to southern ports, and to South America and the West Indies. Some goes directly to Lowell, Worcester, and other New England cities. The average value of saw logs at the mill, per thousand feet, in New England is $8.93. The approximate value of the raw material at the mills, therefore, for one year (1907) is $8,300,000. On the market, at an average price of $25 per thousand board feet, the product is worth over $23,000,000. It becomes evident that the preservation of this industry alone is important. Its future depends entirely upon the care with which the supplies in the northern forests are protected.

METHODS OF LUMBERING SPRUCE.

Spruce lumbering is carried on chiefly by the large paper and pulp companies. Until ten years ago operations were confined mainly to the valleys, where the timber could be obtained easily, but as timber grows scarcer and prices advance, logging is carried on higher up the mountains. On high slopes, where spruce is found in pine stands, clean cutting is invariably practiced, and now extends over hundreds of thousands of acres. A large portion of the trees felled on the slopes are not used, as those under 6 inches in diameter are too small for profit in the making of pulp; but all are felled in order to take away more easily and cheaply the trees of merchantable size. The larger trees are rolled over the prostrate trunks of their neighbors to the logging roads, which are constructed at intervals of about 150 feet on the mountain side. When the logging is complete, the slope has been shaved as by a razor, and the débris is left in inextricable confusion. It invites fire, which almost invariably follows, and consumes not only the débris but also much of the soil, which is composed of vegetable humus. This profoundly changes the character of the soil and the character of later forest growth. Repeated fires in the mountains destroy the capacity of the soil for growing trees, and even destroy the soil itself, leaving only barren rocks. Many thousands of acres have been crippled seriously in their power to produce another forest crop.

At the lower elevations, below 2,000 feet, where spruce grows in mixture with hardwoods, it may be entirely removed and the remaining hardwoods will afford a sufficient forest cover. Fire is less likely to spread through this hardwood timber, although if the slash is heavy it not infrequently does so. A severe fire in a dry season is not checked by hardwood forest, especially if the woods are filled

with the resinous débris of spruce. Here again the character of the forest is changed by the removal of the conifers; because if the spruce seedtrees are removed and the hardwood seedtrees remain, any openings are rapidly seeded up to the less valuable hardwoods. In the White Mountain region hardwoods have not yet reached a price at which they are extensively cut. Every year, however, makes more serious inroads upon them.

A paper and pulp plant is very expensive. It can not be easily removed, and one of the first objects of a paper company is to secure sufficient timber land to insure a perpetual supply. In advertising sales of bonds, every pulp company that can do so announces that it has ample timber lands to warrant repeated cuttings in years to come, and that the method of cutting is such as to foster repeated crops; or, in other words, that when the bonds mature the forest will still be a valuable asset to offset them. With some companies this is much more nearly true than with others, and a few of the large companies make an effort in the direction of conservative lumbering in order to help along a future crop. Several townships in the White Mountain region have been cared for in this manner. Other companies announce that they will "get through" in fifteen or twenty years, and they cut clean without regard to the future. But on the high slopes all of the companies practice clean cutting, for the reason that spruce is shallow rooted, and at high elevations the soil is thin and the winds severe, so that whatever is left is likely to be lost through windthrow. It is often difficult and costly to lumber the high slopes, and the profit must sometimes be small. Yet, since the forest is here more valuable than elsewhere for protecting the soil and preventing a rapid run-off of water, it should not be lumbered except to have the mature trees taken out without greatly disturbing the forest cover. No private corporation can afford to do this, so the present waste must continue, with consequent soil destruction and rapid run-off of water, unless some method of control is devised by which the land may be held for its permanent production of timber and for its best protection to the streams. The time element is important in all forest growth, and on the high mountain slopes, where the summers are short and cold, growth is especially slow. At 3,000 feet elevation it takes spruce one hundred and twenty-five years to attain a diameter of 6 inches. No private corporation, however well it cares for forests in the valleys, will plan for future returns at this slow rate, or even where the rate may be accelerated by good forest management. In the long run, even at the slow rate, it may prove entirely profitable to hold and manage the forests, as shown by the returns from the public forests abroad; but private corporations or individuals can scarcely make such long-time investments and wait for the returns.

Some of the companies have purchased large tracts of land in the vicinity of the White Mountains, which are not being cut, but held for future use. Probably more than 200,000 acres are thus held. As far as practicable these companies get their present supplies by purchasing stumpage on small holdings, in order to preserve the timber on their own land. When these small holdings are thus lumbered they are usually "skinned" to the last merchantable stick, as the high slopes are. Owners of the smaller tracts themselves sometimes treat their woodlands in this manner and cut everything to get present revenues. Throughout the mountains the clean cutting has been on high slopes and on small holdings, and on these fire has followed with the worst results. Two of the companies that hold large tracts of spruce in the mountains import a large part of their logs from Canada in order to protect themselves against emergencies.

Two of the large companies have cut chiefly for saw logs and their lands show much valuable forest remaining, besides a promising young growth. One of these has twice cut over some of its areas, once to a diameter of 14 inches and later to a diameter of 10 inches, with still a fair growth of small and growing trees left standing. Two of the hotel companies having tracts of about 10,000 acres each have preserved the hardwoods, and one has done considerable planting and judicious thinning of conifers.

The fact that spruce is used to so large an extent in the manufacture of paper, and that its area of growth in the United States is limited to a few States, makes its amount and duration a question of vital moment; and the fact that paper is so widely used, especially news paper produced from spruce pulp, makes the welfare of any large tract of spruce, like that in the White Mountain region, a matter of concern to people and interests far beyond New England.

TABLE 6.—*Spruce cut into lumber and spruce used for pulp in 1907.*[a]

Locality.	Lumber cut.	Pulpwood.		Pulp mills.
		Domestic.	Imported.	
	M bd. ft.	*M bd. ft.* [b]	*M bd. ft.* [b]	*No.*
Maine	528,013	.....	.....	.....
New Hampshire	203,092	.....	.....	.....
Vermont	156,354	.....	.....	.....
Massachusetts	43,141	.....	.....	.....
Total for New England	930,600	[c] 536,545	[c] 227,315	[c] 66
New York	166,048	245,550	251,064	92
Lake States	(*d*)	143,218	23,181	53
West Virginia	198,544	(*d*)	(*d*)	(*d*)
Pacific States	268,334	(*d*)	(*d*)	(*d*)
All others	163,271	100,560	15,911	31
Total	1,726,797	1,025,873	517,471	242

[a] Figures from Census circulars, Forest Products No. 1, Pulpwood Consumption, 1907, and No. 2, The Lumber Cut of the United States, 1907.

[b] Allowing 1¼ cords per thousand board feet.

[c] Pulpwood figures not reported separately for the individual States in New England.

[d] Included in "All others."

THE HARDWOODS.

Throughout the White Mountains the hardwoods form a large portion of the standing forests at elevations below 2,000 feet. Above this elevation yellow and paper birch are found in mixture with spruce, but seldom in commercial quantity. On the lower slopes and in the valleys the soils are deeper and richer, and give the deeper root systems of the hardwoods an opportunity to develop. Maples and beech, with the birches, are the leading species. Aspen is abundant on cleared areas and burns. As this is a short-lived tree it is not found in the old forest, and its presence indicates that a clearing has been made either by wind, fire, or the ax, within, at most, one hundred years.

Owing to distance from market the hardwoods in this region have not as yet been seriously exploited. Aspen has been cut to a considerable extent for pulp and excelsior, because when peeled it floats and can be driven down the streams. Near the railways birch and maple have been used to some extent for flooring, but the attention of the operating companies appears to have been occupied hitherto with cutting the virgin spruce, which has been far more profitable than hardwood operations. Birch is used in the manufacture of bobbins, for which there are in the White Mountain region nine mills requiring 10,845 cords (1903) to produce 47,000,000 bobbins—this term including speeders, quills, and rolls. The product is rough bobbins, as none of the mills finish them. The larger part of the output goes to the U. S. Bobbin and Shuttle Company, whence it is distributed throughout the country. Several mills produce shoe pegs, also from birch, a product used almost entirely abroad.

The most extensive hardwood stands are located on the southern and southwestern slopes of the mountains, and some of these have been culled for saw logs, but by far the greater portion of the hardwood lands have been lightly cut, if at all, and are in fair condition. If cared for and cut in a conservative manner they may afford a resource of very great value for generations to come; but as prices advance, and these forests are cut exclusively for present revenues, fire and erosion will do for them what they are doing for the spruce slopes, and make many of them unproductive for long periods of time, if not permanently. There is here a great opportunity to make these forests serve the growing needs of the people throughout the Northeastern States, but they must quickly be taken in hand before they have been despoiled. Their value at present is largely determined by the price of cordwood.

The following table shows in a striking manner how the demand in the country at large is turning back to the eastern mountain forests

for hardwoods as the supply in the Central and Lake States becomes more nearly exhausted:

TABLE 8.—*Cut of hardwoods in New England States compared with other States, in 1899 and 1907.*

State.	1899.	1907.	Increase.
	M board feet.	*M board feet.*	*Per cent.*
Maine	28,730	72,620	153
New Hampshire	23,468	58,107	148
Vermont	50,423	99,297	97
Rhode Island	3,988	18,617	367
Connecticut	77,594	99,406	28
Total New England	184,203	348,047	89
Total four Middle Atlantic States [a]	765,578	1,095,328	43
Total three Lake States [b]	1,392,636	1,309,300	c 6
Total eight Southern and Central States [d]	2,689,848	3,477,225	29
United States	8,634,021	9,254,929	7

[a] New York, New Jersey, Pennsylvania, and Delaware.
[b] Michigan, Wisconsin, and Minnesota.
[c] Decrease.
[d] Maryland, Virginia, West Virginia, North and South Carolina, Georgia, Kentucky, and Tennessee. All States in this group show an increase in the cut of hardwood, which is largest in North Carolina (159 per cent), except in Tennessee, which shows a decrease of 15 per cent.

Table 8 shows that the hardwood supply is decreasing in nearly every part of the United States in which large bodies of hardwoods have been standing, except in the States of the Northern and Southern Appalachian Mountains. This decrease of supply that comes in a time of ever-increasing demand means the beginning of exhaustion. Heavy inroads into the mountain forests are now being made, particularly in northern New England. The increase in the amount cut in Maine and New Hampshire from 1899 to 1907 is about 150 per cent. The hardwood forests of the White Mountains are still in excellent condition, with many virgin stands and many that have been only lightly culled. To lumber these without a plan and to allow them to be destroyed through bad methods is unintelligent. In view of the very important place in the national economy which these forests can fill, if properly cared for and conservatively cut, no time should be lost in placing them under adequate care. Every month under the present lack of system adds to the deficiency which is approaching.

THE EXTENT AND RESULTS OF FOREST FIRES.

Fire has been more destructive than the ax in the White Mountain forests. The mountain soils contain much material of vegetable origin which is inflammable, and when it is consumed the result is unfavorable to the growth and character of another forest. Single fires have swept over as much as 10,000 acres, and have exceeded 30,000 acres. A total of 84,255 acres were burned over in one year,

1903; a fire covering 9,000 acres occurred in the East Branch Valley of the Pemigewasset River in the town of Lincoln in September, 1907. The fires, spreading repeatedly over certain large areas once covered with forests of the best quality, such as Zealand Valley, Cherry Mountain, and Pine Mountain, have so destroyed the productive quality of the soil that practically nothing has grown in twenty years—since the fires first spread over them. The soil is so injured that another forest probably will not begin to appear until after the lapse of a century. Mount Oscar, the three Sugar Loaves, and parts of Mount Hale afford striking additional examples, where the soil has been rendered completely and permanently barren. There are more than fifty thousand acres in the mountains approaching this condition. It is probable that the total area burned over in the mountain region of northern New Hampshire is not far from 250,000 acres. The period in the spring of 1903, April to June, "fifty-two days without water," was exceptional, but likely to recur at any time. Year by year fires make the mountain region less productive, with more barren and half barren stretches. There is a progressive evil effect from which the mountain tracts do not recover. Though much of the burned land comes up to bird cherry and to popple, or even to more valuable hardwoods, and finally, after very many years, to another growth of spruce and fir, it does not have the vigor of the primeval forest. The destructive result is progressive, inevitable, and portentous. The timber-growing properties of the soil are injured if not destroyed, and the protection afforded by the forest in holding back moisture is lessened. From each of these points of view the protection of the White Mountains from fire becomes a matter of general concern to the country at large.

CAUSES OF FIRE.

Chief among the causes of fire are sparks from locomotive engines, either upon the through railways or upon the logging railways. Several of the largest fires have started from the latter. Occasionally fires start from sawmills, especially where there are small mills in the woods to cut up pulp wood for loading on the cars. A frequent cause is the carelessness of individuals in the woods.

Fire seldom sweeps through virgin forest; the slash left by lumbering is a chief promoting cause of fire, and it is in the slash that nearly all fires originate. A map of the fires in the White Mountain region shows that they have closely followed the cut-over areas.

PROTECTION FROM FIRE.

It is the duty of the State to protect forests, as well as town property or dwellings, from fire—a duty seldom recognized as yet, but

likely to be more so in the future. Up to the present time no method has been devised by which the cutting of private owners can be regulated, and fire almost invariably follows cutting as carried on by private individuals and corporations in the mountains. In New England there are two recognized fire periods—the dry springtime after the snow has gone and before the new leaves have appeared, a period of from one to three weeks; and a shorter period in the fall after the leaves have fallen and dried, but before snowfall. The springtime is by far the more dangerous. In about three years out of five it may be necessary to patrol the woods in dry times to prevent the setting of fires in the woods and to put them out if they get started. Once a forest fire gets well under way, it becomes difficult if not impossible to put it out; but small fires can be handled. An adequate patrol of the woods could readily be put in force, though it is expensive and seldom undertaken. The state government can and should do this, with the cooperation of private owners, but so far few States have attempted it. If all the land were under one control, a comprehensive plan could be put into operation, and fire protection be made a part of lumbering. In the National Forests in the West, for example, where slash is properly taken care of, fires that formerly ruined many hundreds of thousands of acres are now of rare occurrence.

INFLUENCE OF THE WHITE MOUNTAIN FORESTS ON WATER POWER.

The White Mountains form the great watershed of New England. From them flow five great rivers, the most important in New England; the Connecticut, the Merrimac, the Saco, the Androscoggin, and the Kennebec. On these streams are the great cotton, woolen, and paper mills of New England, the largest in the world. They abound in water powers, developed and undeveloped. A conservative estimate places the capital invested in manufacturing enterprises upon the several falls of these rivers at $250,000,000. In each of the New England States, except Rhode Island, important and flourishing cities have grown up around the falls, with populations of from 10,000 to 150,000 people; such cities as Holyoke, Lowell, and Lawrence, in Massachusetts; Bellows Falls, in Vermont; Manchester and Berlin, in New Hampshire; Biddeford, Lewiston, Rumford Falls, Augusta, and Bath, in Maine. Berlin, N. H., and Rumford Falls, Me., both on falls of the Androscoggin River, are still making rapid growth through the development of the paper and pulp industry.

Upon these water powers New England's manufactures chiefly depend. They are the foundation and source of her greatest wealth. Without coal, and distant from the coal fields, far from the cotton belt, cheap water power has enabled New England to maintain

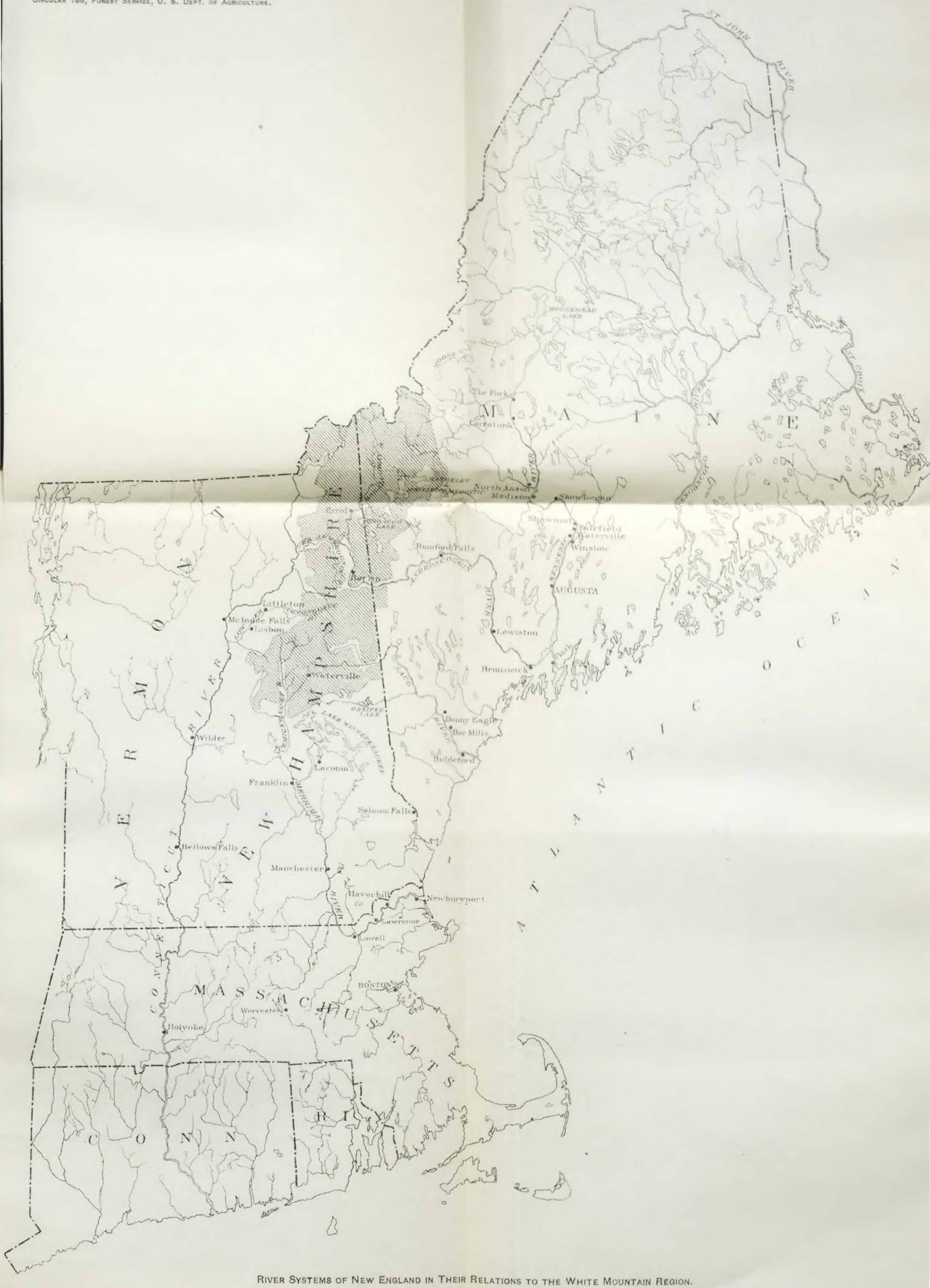
her industrial position against the competition of more favored localities.

The connection between forest cover and stream flow is intimate. The evil effects of forest destruction are profoundly marked in the older Asiatic and European countries, where the pressure of population upon wood supply has consumed the mountain forests. France is now spending extraordinary sums in an effort to reforest denuded mountain sides, even going so far as to construct walls of masonry to hold back the soil. In cutting a mountain forest few individuals and probably fewer corporations feel that their work makes any difference. They do not realize that Nature is slowly wearing away the mountains down to the sea, and that the forests are the chief barriers to this process. With fire the deterioration is immediate and often complete.

This relation of forest cover to stream flow is no less substantial in the White Mountains than elsewhere, but the ill effects upon the industries using the water powers are thus far less apparent than in some other parts of the country. Cutting the forest from the steep slopes tends to swell the floods and accentuate low water, but the topography of New England is such that long ridges extend across it parallel to the sea, the last one not very far from the coast. These are some distance from the mountains. The streams, before flowing over them, have gathered full force from numerous tributaries, some of which are a considerable distance from the main watershed. To affect this volume of water the cutting must cover a very wide area. The New England rivers, except the Connecticut and the Saco, have an unrivaled system of lakes, which serve as storage reservoirs. Dams at the outlets of these store large quantities of water that can be let out at will in time of drought. Lake Winnepesaukee, the Rangeley Lakes, and Moosehead Lake make the best reservoirs, and partially overcome the effect of denudation. The mountain run-off areas are about equally apportioned to the five principal watersheds, so that the bad effect of denudation is also divided.

Yet, on the other hand, extensive denudation at the headwaters of a stream must affect more or less its main current. Moreover, there are found nearer and within the mountains extensive water powers, some of them yet to be developed, that depend directly upon the forest. The Connecticut River has no large lake reservoirs. The Saco has none, except that the water from Ossipee Lake finds its way by a separate channel into the Saco River near its mouth. Furthermore, the maintenance of water in the lake reservoirs depends upon the forests. All water powers, therefore, depend more or less upon the mountain slopes. It is upon the steep slopes that floods gather. Their protection from every point of view is important.

The value of a water power is gauged by low water, for while works may be so constructed as to avoid damage from ordinary freshets,



River Systems of New England in Their Relations to the White Mountain Region.

[The shaded area represents nonagricultural mountain lands.]

they are helpless against the absence of sufficient water in time of drought The only recourse is the use of supplementary steam mills at great expense in construction and maintenance.

A considerable amount of power from the falls on the several rivers is used in the generation of electricity. In this respect water power in the future is likely to be more important than in the past. With electric power transmission, factories need no longer be in an inconvenient place at the waterfall, where market and transportation facilities are both absent. It permits the development of power high up in the mountains at points formerly regarded as inaccessible. If the coal fields shall ever become exhausted, as it is claimed that they may, water powers will become still more valuable as sources of light, heat, and power.

Those who use the water powers most constantly realize that the preservation of the mountain forests is important. Hon. T. Jefferson Coolidge, of Boston, president of the Amoskeag Manufacturing Company, says:

> For some years the manufacturing establishments on the Merrimac River in New Hampshire have suffered seriously from the cutting down of the forests. One freshet, a few years ago, cost the Amoskeag Company more than $100,000. Besides the injury done by the excessive flow of water in freshets, we suffer also in the same way from absence of water during dry seasons, as the woods no longer retain the water. It is emptied at once, and not held back to trickle slowly into the streams. But New Hampshire is not the only State. * * * The Connecticut, the Merrimac, and the Saco all have their sources in the White Mountains, so that Vermont, Connecticut, and Massachusetts are equally interested, and even the Androscoggin derives part of its stream from the country north of the White Mountains.

All of the most important companies in New England using large water powers have put themselves on record as indorsing a method of control of the forests that will preserve their powers through preservation of the forest.

WATER-POWER DEVELOPMENT.

A brief description of the water-power development on each of the five large rivers flowing from the White Mountain region will bring into clear view the interstate features of this water-power problem and call attention to the vast amount of business and its wide ramifications that depend upon the protection of the sources of power.

CONNECTICUT RIVER.

The Connecticut rises in the extreme northern portion of New Hampshire, within half a mile of the Canadian border, and flows south for 300 miles to Long Island Sound. The river itself, if the bends are followed, is about 375 miles long. It forms the boundary between New Hampshire and Vermont for 180 miles and for 120 miles traverses Massachusetts and Connecticut. Its total drainage

basin includes about 11,000 square miles (10,924), of which about 2,500, or nearly one-fourth, lie in New Hampshire. About 2,000 square miles of its catchment basin are in the White Mountain region of New Hampshire, and its tributaries in this area are shown in the following tabulation:

TABLE 9.—*Streams flowing from the mountain region in northern New Hampshire into the Connecticut River.*

Name of stream.	Drainage area, square miles.
Perry	27
Indian	67
Halls [a]	88
Upper Ammonusuc	252
Israels River	129
Johns River	86
Lower Ammonusuc	388
Total	[b] 1,937

The sources of these tributaries of the Connecticut are found at high altitudes. The third Connecticut Lake, which is the source of the main river, is 2,038 feet above the sea. Thence, over thirteen or more dams which store the water for log driving or make it available for local mills, it falls 1,600 feet in 113 miles, and 430 feet in the remaining 262 miles. In its upper reaches it is a turbulent stream, with tributaries (Halls, Perry, and Indian streams) of the same character.

The eastern edge of the watershed through the White Mountain region averages about 4,000 feet elevation and includes the great mountains of the Presidential and Franconia ranges from Mount Madison to Mount Moosilauk, many of them above 5,000 feet. The steep and rocky slopes, without large lakes or swamp areas, cause an uneven flow, restrained solely by the moisture-holding power of the forest. The upper water powers are developed chiefly at Fifteen Mile and McIndoes Falls on the main river, and at Littleton and Lisbon on the Lower Ammonusuc, but the region has many local mills of small individual output, yet with a total product of considerable value. McIndoes Falls, which mark the lower end of the turbulent part of the Connecticut, 7 miles above Wells River, has a fall of 12 feet, and more than 1,000 available horsepower, of which 400 has been utilized for many years by a large sawmill. At Littleton various wares and lumber are manufactured, and at Lisbon chiefly lumber. One company at Lisbon manufactures piano sounding boards from spruce butts, a product that in its final form is widely distributed throughout the United States.

[a] Includes a small portion of the watershed lying in Canada.

[b] There are several other small streams, the Mohawk for instance, with drainage areas of about 20 square miles.

Lumbering has been carried on extensively in this northern Connecticut region for a great many years, and especially during the past ten years, when the slopes of the Presidential and Franconia ranges have been cut for pulp, and many of them burned over, exposing the bare rock. In 1880 it was estimated that the annual drive down the Connecticut amounted to more than 60,000,000 board feet, and that from 10,000,000 to 12,000,000 board feet were sawed annually in the mill at McIndoes Falls. This is about the present output, which has probably been fairly steady during the intervening twenty-eight years. It appears therefore, that more than two billion feet have been removed from this part of the watershed since 1880. In the northern townships saw logs have been cut more than pulpwood, which leaves the forest in good growing condition, with a forest cover sufficient to protect the moisture in the soil. The situation is very different in the high mountain townships that have been stripped for pulp. Under the present cut the stand of timber deteriorates every year over a large part of the forested area, and is disappearing rapidly on the high slopes, where clean cutting is the only method used.

Below McIndoes Falls the Connecticut has long reaches of smooth water, broken at seven points by water powers of high efficiency and value. These are indicated in the following tabulation:

TABLE 10.—*Water power on the Connecticut River below the Passumpsic River.*

Locality.	Horsepower available, 10 months, average year.
McIndoes Falls	1,570
Dodges Falls	1,570
Wilder	7,160
Sumners Falls	4,000
Bellows Falls	17,720
Turners Falls	31,950
Holyoke	35,100
Windsor Locks	21,130
Total	120,290

About one-half of this 120,000 horsepower is utilized. In low water of a dry year the efficiency is reduced nearly one-half. In several places the works are so constructed as not to utilize the total available power, as at Windsor Locks, above Hartford, where the dam was put in about seventy-five years ago for the purpose of aiding navigation. The margin of power between that available on the wheels and that used daily in the mills is sometimes small, as at Holyoke, where the mills are many. Low water in a dry year at such places causes no little anxiety. The slightest rise above is reported at Holyoke, in order that supplies of water to the mills below may not be cut off unnecessarily. At Holyoke there are upwards of 20 mills engaged in the manufacture of paper, several cotton mills, using about

200,000 spindles, besides mills that manufacture machinery, water wheels, pumps, cutlery, woolen goods, and rubber goods. In five leading industries in Holyoke—book binding, foundry and machine products, paper and wood pulp, cotton goods, and woolen goods—nearly twenty million dollars are invested (1900), employing nearly ten thousand wage-earners, and producing an annual product valued at more than sixteen million dollars.

The water powers on the Connecticut serve a wide variety of uses. There were, according to the Census of 1880—the latest figures available—212 mills, that used 27,815 horsepower; since 1880 there has been a 20 per cent increase in the use of power. Of these mills, 52 are sawmills, 31 are paper mills, 31 are for woodworking, 28 are for metal working, 15 are flour mills, 8 each are cotton and woolen mills, 2 are silk mills, and 23 are for other purposes. The paper mills used 15,006 horsepower, or more than half; the cotton mills, 3,441 horsepower; and the rest, lesser amounts down to the 110 horsepower used by the 2 silk mills.

On the Connecticut River, including its several tributaries, which afford water powers even more valuable in the aggregate than those upon the main stream, 2,298 mills of all kinds had been erected in 1880, using a total water power of 118,026. It is estimated by engineers that the present total horsepower used on the Connecticut is between 140,000 and 160,000.

MERRIMAC RIVER.

It is said of the Merrimac that it is "the most noted water-power stream in the world." The river is formed by the union of the Pemigewasset and Winnepesaukee rivers at Franklin, 110 miles from the sea. Its great powers are located at Manchester in New Hampshire, and Lowell and Lawrence in Massachusetts, while the power of the Winnepesaukee at Franklin, before it joins the Pemigewasset, is scarcely second to the powers on the main stream. On the tributaries of the Merrimac, as of the Connecticut, there are extensive and very valuable water privileges.

The Pemigewasset River rises in the high slopes of the Franconia range in the White Mountains, and has its source in springs, small lakes, and ponds, at elevations ranging from two thousand to nearly five thousand feet.[a] The source of the main stream lies under the famous profile of the Old Man of the Mountain and is a quiet pool called Profile Lake, 1,950 feet above the sea. As the flow of the Pemigewasset River is variable, being in and near the high mountains, with no large lakes to aid in regulating it, the conserving power of the forest alone restrains it.

[a] The Evergreen spring near the top of Mount Lafayette is 4,900 feet high.

On one of the branches of the Pemigewasset, the East Branch, in Lincoln, forest destruction has gone far. The operating company does not expect any future return after the primeval forest is gone. It cuts clean and has no care for the future of the forest. From 50,000 to 75,000 acres are already laid bare; on most of it nearly every tree has been cut, save the hardwoods of little present value in the valleys. A fire of 9,000 acres' extent in September, 1907, was but a beginning. It has become almost literally true that, where until recently stood a primeval forest, after cutting there remains standing scarcely a pole on which a bird can build its nest. With a masterly business management railways are constructed through these valleys and removed when the forest has been exhausted.

During the last three winters extensive cutting has been done also on Moosilauk Brook, which is known as the Lost River, the axmen having stripped the timber ruthlessly from this remarkable natural curiosity. On the opposite side of the valley in Thornton Gore another extensive block of timber has been removed, chiefly by clean cutting. As little by little these operations are extended, and fire does its finishing work, the result upon the flow of the Pemigewasset becomes apparent. The work is too recent in its greatest extent for results to be reported fully in stream measurement, but the mark has been made, as shown clearly in the accompanying chart. That this cutting will have immediately marked effect upon the water powers in the lower Merrimac River at Lowell and Lawrence is doubtful, because the companies owning these powers control the great lakes of the Merrimac system—Winnepesaukee, Squam, and Newfound lakes—comprising together a surface area of 103 square miles. These lakes have a vast storage capacity, controlled by dams at their outlets, which are opened sufficiently to offset in large measure low water in the main lower stream. It is believed, however, that the conserving power of the forest is greater than that of the combined lakes. There is a progressive evil effect from forest destruction, which in time may prove overwhelming, for the wounds upon the primeval forest at high elevations are very slowly repaired. The forest on the upper reaches of this river have been cut closer than any others in the mountains. In the long run nature has her way, and the efforts of man to prevent it on a large scale are always expensive and sometimes fruitless.

The articles manufactured on the water powers of the Merrimac are somewhat less varied than those on the Connecticut, being chiefly cotton goods, but the investments of capital are very large, estimated at Lawrence to be about $15,000,000, with a greater amount at Lowell, and a somewhat smaller amount at Manchester. The total investment on this river is conservatively estimated at

$100,000,000. Several million dollars have been expended upon canals and dams alone, one canal at Lowell having cost more than $500,000. Two canals at Lawrence cost $250,000 each. The population in the ten water-using cities, from Laconia on Lake Winnipesaukee to Newburyport on the sea, is about 400,000.

Table 11 indicates the volume of business in only a few industries at Lawrence, Lowell, and Manchester dependent upon the water powers of the Merrimac at those places.

TABLE 11.—*Value of annual product and number of wage-earners in certain industries on the Merrimac River, 1905.*[a]

Place.	Industry.	Value of product.	Number of wage-earners.
Lawrence	Cotton goods	$5,745,611	3,956
	Dyeing and finishing textiles	1,428,174	1,158
	Foundry and machine shop products	1,418,491	897
	Paper and wood pulp	1,650,206	599
	Worsted goods	30,926,964	12,216
Lowell	Cotton goods	19,340,925	12,936
	Foundry and machine shop products	3,438,729	2,294
	Hosiery and knit goods	3,816,964	4,324
	Woolen goods	2,579,363	1,391
	Worsted goods	1,978,552	1,235
Manchester	Cotton goods	14,366,061	9,884
	Total	86,690,040	50,890

[a] Census of Manufactures, U. S. Department of Commerce and Labor.

SACO RIVER.

The source of the Saco River is in a small lake at the top of the Crawford Notch, 1,900 feet above the sea. It flows in a southeasterly course about 75 miles to the sea, or 104 miles measured on the river, and drains a basin of 1,750 square miles, almost exactly one-half of which lies in New Hampshire. The streams that unite to form the Saco drain the steep south slopes of Mount Washington, the Presidental Range and the mountains southward, including Mount Chocorua and most of the Sandwich Range. The main stream falls more than 1,100 feet in the first 14 miles and 333 feet in the next 18 miles. Like the upper reaches of the Merrimac these streams have no lakes to restrain their flow, and are held back solely by the forests on the mountains. They are variable streams, and in New Hampshire not much used thus far as water powers. In Maine the current flows over level stretches, broken at six places by falls affording power sites of a very high order. The lake drainage, which affects the lower Saco River only, is considerable, the lake surface covering 84 square miles. Not all of the powers on the Saco have been developed, nor even carefully estimated. The theoretical horsepower, therefore, can only be generally stated at about 60,000.

Along the mountain streams of the Saco extensive lumbering operations have been carried on. Recently the large paper and pulp companies have begun to cut clean extensive areas on the high slopes. Three of the largest companies are now at work on the Saco streams, and one of them has built recently 12 miles of railroad up the Swift River to facilitate the handling of logs. Another lumber railroad has been constructed up the valley of Rocky Branch into a fine stand of spruce timber, one of the last large bodies of virgin spruce remaining in the mountains.

Because of the small areas of lake surface, the upper Saco basin, like that of the Connecticut, is more directly influenced by forest destruction than the Merrimac or the Androscoggin. Its water powers are very extensive and valuable. At Saco and Biddeford, at the head of navigation, a fall of 40 feet occurs, where 3 cotton mills and a sawmill utilize about 5,500 horsepower. Eight miles above, at Union Falls, 15 feet of fall is utilized; at Salmon Falls, a little higher, a fall of 20 feet. Still higher, at Bar Mills and Bonny Eagle, there are good powers which are only partly utilized. Still farther up the stream, at Hiram, 45 miles from the sea, is the largest power on this river. Here the river falls 72 feet within a distance of 900 feet, but the power is little used.

The Saco powers offer attractions to manufacturers, but it is likely that few will establish large mills upon this river until the effect of the logging operations on the mountain slopes is more clearly demonstrated.

ANDROSCOGGIN RIVER.

The Androscoggin drainage basin has a higher general elevation than any other in New England, and its lake surface is larger, covering one-seventeenth of its entire watershed. Its water powers, therefore, are very large, being three times those of the Merrimac. At Berlin, N. H., and at Rumford Falls, Me., paper mills, among the largest in the world, have been erected recently, and at Rumford Falls the horsepower still unutilized gives promise of continued large investments. The river is formed, 110 miles from the sea, by the union of the Magalloway River and the outlet of Umbagog Lake, the lowest of the great Rangeley lake system. At this point, Errol, N. H., a large dam diverts the water from the Magalloway into Umbagog Lake, which thus becomes a vast storage reservoir. The drainage basin of the Magalloway is 420 square miles, and the water level of Umbagog Lake varies 12 feet between high and low water stages. The lake is about 100 square miles in area and its great storage capacity is further increased by dams at the outlets of the other large lakes above Umbagog. These lakes are Richardson, with a water level variation of 22

feet; Mooselookmeguntic, 18 feet; and Rangeley Lake, 3 feet. The flow of the Androscoggin therefore is both powerful and steady. The Rangeley Lakes are about 1,500 feet above the sea, giving ample fall to a vast quantity of water.

The total drainage area of the Androscoggin includes 3,700 square miles. A portion of the water in this river comes through the Peabody River directly from the highest of the White Mountains, including the Presidential and Carter-Moriah ranges. The edge of its watershed in this part has an elevation averaging 4,000 feet. In this vicinity the commercial spruce forest has been largely removed by the clean cutting method. The sources of the Magalloway River, the main tributary of the Androscoggin, lie about half in New Hampshire and half in Maine, in the mountains that form a part of the White Mountain system, north of the Presidential Range. The dense forest cover of this drainage area contains several townships that have been lumbered conservatively by the large companies, such as the Gilmanton and Atkinson Academy grant, which is in good condition for future growth, though recently lumbered. Here also lies the Dartmouth College grant, a tract of 26,000 acres, which the college has put under forest management. North of these two tracts, and almost in the upper corner of New Hampshire, occurs the most extensive virgin spruce forest that remains in the White Mountain region.

The water powers of the Androscoggin have been most extensively developed at Berlin, N. H., and at Rumford Falls, Livermore Falls, Lewiston, and Brunswick, Me. The dam at Errol and several of the important powers are controlled by the Union Water Power Company, an old and well-established corporation. Great drives of spruce, estimated at more than 100,000,000 board feet, come down the Androscoggin annually. At Berlin the river falls about 200 feet in 1 mile; at Rumford Falls, 177 feet. The latter has the better water power of the two, though both are among the best in New England.

At Brunswick, Lewiston, Livermore Falls, and several intervening points, extensive use is made of the water powers, and the range of manufacture is wide, including 8 cotton factories, 7 paper and pulp mills, 2 electric lighting plants, sawmills, gristmills, wood-working factories, and others, using altogether about 30,000 horsepower.

The great possibilities of the Androscoggin as a power stream are shown in comparison with the power values of the Merrimac, already world famous for its manufactures dependent on stream flow.[a]

Merrimac River.—In the total length of the Merrimac River from Newburyport to Franklin, a distance of 110 miles, there is a fall of 269 feet. Of this amount 185 feet is developed, representing approximately 50,000 net horsepower. Of the remaining 84

[a] In comparing the Merrimac and Androscoggin, it must be kept in mind that the Merrimac has a larger number and more important tributaries than the Androscoggin and for this reason the difference in power might not be quite as great as shown. This comparison has been prepared by Mr. H. K. Barrows, of Boston.

feet undeveloped, it is doubtful if more than half can be utilized, and probably the total development on the river will never exceed 60,000 net horsepower.

Androscoggin River.—In the 167 miles between tide water at Brunswick and the surface of Umbagog Lake at Errol dam, New Hampshire, there is a fall of 1,235 feet. Of this amount 610 feet are developed, corresponding to about 120,000 net horsepower. Of the remaining 625 feet undeveloped, possibly two-thirds will in time be utilized, this corresponding to, roughly, 60,000 net horsepower, making a total for the river in the future of 180,000 net horsepower, or about three times that possible on the Merrimac River.

KENNEBEC RIVER.

The Kennebec takes its rise in Moosehead Lake, a body of water 120 square miles in area, with a water level variation of 7½ feet, controlled by a dam at its outlet. The power afforded by storage of water in this lake is very great, and, excepting the Great Lakes, is hardly equaled by any storage reservoir in the country. Twenty-three streams empty into it, either directly or through the Moose River, and it has a total drainage area of 1,240 square miles. At Augusta, at the head of tide water on the Kennebec, the total drainage area is 5,580 square miles, and at Merrymeeting Bay, where the river enters the sea, it drains 390 additional square miles, and the total drainage area includes about one-fifth of the entire State of Maine. Moosehead Lake is 1,026 feet above the sea, and the Kennebec River falls, on an average, 8.55 feet per mile for 120 miles between the outlet of the lake and Augusta. Only about 153 feet of this fall, however, has been developed. The river basin contains 311 separate lakes and ponds, which comprise altogether one-fourteenth of the entire watershed. The seventeen largest towns and cities contained in 1900 a total of 58,440 inhabitants, which is probably about one-third of the population of this river valley.

The upper Kennebec basin was, in 1902, covered with extensive forests of spruce and aspen. These covered, on the estimate of the state forest commissioner, 2,350 square miles, and contained nearly 4,000,000,000 feet of standing spruce suitable for lumber and pulp. About one-third of all lumber and pulp used in Maine comes from the Kennebec basin, and the remainder almost wholly from the Androscoggin and the Penobscot basins. It has been estimated that the annual drive in the main river amounts to about 150,000,000 feet board measure. To float such vast quantities of timber from the mountains to the sawmills and paper mills requires vast quantities of water from Moosehead and the other lakes. This formerly left very little to steady the flow of the river at the factories throughout the rest of the season. This resulted in great friction between the Kennebec Log Driving Company that has taken charge of the annual "drive" since 1830, and the Kennebec Water Power Company that has made extensive improvements along the river in order to secure an even flow of water at the mills. This friction now has been removed, and

there has been a very considerable saving in the amount of water used to drive out the logs. Between 1901 and 1905 the sum of $74,200 was spent by the two companies in smoothing the channel so that there would be fewer log jams and consequently less extra expenditure of water. It has been estimated that the cost per ton-mile for driving logs varies on this river from one-fourth to 1½ cents, while the cost by rail on near-by roads for the same service is 2.74 cents per ton-mile.[a] Log driving, therefore, is likely to continue.

The principal developed water powers on the Kennebec River are shown in Table 12.

TABLE 12.—*Developed water powers on the Kennebec River.*

Location.	Operating companies.	Horse-power.
Carritunk Falls	International Paper Company	3,000
Madison	Great Northern Paper Company	1,400
Madison	Indian Spring Woolen Company	400
Madison	Madison Woolen Company	400
Skowhegan	Skowhegan Water Power Company	5,100
Shawmut	Shawmut Manufacturing Company	1,000
Fairfield	Fairfield Junction Mills	1,000
Winslow	Hollingsworth & Whitney Company	8,500
Ticonic Falls	Lockwood Company	2,400
Augusta	Edwards Manufacturing Company	2,500
Augusta	Cushnoc Paper Company, etc	1,500
Total		26,700

The reports indicate that about 4,000 of the horsepower is used in developing electricity for lighting five or six leading towns and cities and for running street cars. The extensive undeveloped powers of this river are, in the main, above Skowhegan.

A significant and very interesting table (Table 14, p. 28) showing the effect of storage water in Moosehead Lake upon the flow of water at points below is given under the next heading.

INFLUENCE OF THE WHITE MOUNTAIN FORESTS ON NAVIGATION.

All of the five large rivers of New England that rise in the White Mountain region are navigable at their mouths. In this respect the most important is the Connecticut, navigable for 50 miles, with a fleet of 35 vessels plying between Hartford and New York. The Kennebec is navigable for 44 miles, to Augusta; the Androscoggin 30 miles; the Merrimac 17½ miles, to Haverhill, and the Saco 5 miles, to Saco and Biddeford. In each case large cities receive supplies by water. The combined navigable length of these rivers is 146½ miles, a natural highway for freight and passengers, which, were it to be built as a canal, would necessitate an initial expenditure of several

[a] "Water Resources of the Kennebec River Basin," by H. K. Barrows, U. S. Geological Survey, Water and Irrigation Paper No. 198.

millions of dollars. Table 13 shows the freight tonnage in 1905 and the cost of improvements by the United States Government, together with other facts.

TABLE 13.—*Rivers which have their sources in the White Mountains, showing, for each river, distance navigable, annual tonnage according to latest statistics, total appropriations 1790 to 1907, average expenditure of government money per mile, tonnage of commerce per mile according to latest statistics, and tonnage (1905) for each dollar spent by the Government, between 1790 and 1907, for improvements.*

Name of river.	Miles of navigable water.	Tons of freight carried in 1905.	Appropriations by the Government from 1790 to 1907 for improvements.	Total cost of improvements per mile of navigable water.	Average tonnage per mile of navigable water in 1905.	Average tonnage on the river in 1905 for each dollar spent by the Government for improvements from 1790 to 1907.
Kennebec	44	400,735	$667,445.71	$15,169.22	9,107.61	0.6004
Androscoggin	30					
Saco	5	48,537	346,775.00	69,355.00	9,707.50	.1390
Merrimac	17½	88,324	825,366.72	47,162.09	5,047.07	.1070
Connecticut	50	673,383	737,510.69	14,750.21	13,467.66	.9170
Total	146½	1,210,979	2,577,098.12	17,591.11		
Average					8,266.07	.4699

The influence of forest removal upon navigation is marked in three ways—it increases the floods, it makes the low-water stages lower and prolongs them, and it deposits large quantities of silt in those parts of the streams where obstruction is most objectionable.[a]

George F. Swain, professor of civil engineering in the Massachusetts Institute of Technology, says of the first of these influences:

> Some of the effects on the streams of wholesale destruction of timber are perfectly well known. It is certain enough that they are subject to more sudden fluctuations and are less sustained in droughts than before the country was cleared. These results are matters of common observation among men whose memories reach back over fifty, forty, or even twenty years; it is a universal complaint in New England that the mill streams are less reliable, except of course where artificially reservoired, than they were that length of time ago, and this is due both to the clearing of land and the drainage of swamps. The principal freshets in the region under discussion are caused by the melting of snow in the spring, and while the effect of forests is, by shading the ground, to prevent this going on too rapidly, so on the other hand their destruction lays the surface open to the direct action of the sun and gives a good opportunity for a quick melting away of the snow. The record of the heights of freshets in the Connecticut for thirty-five years back shows that in this stream, whether we have regard to the highest freshets of the year or to the highest occurring during the first five months, which latter may be supposed to have connection with the melting of the snow, there has been a considerable increase in the average heights reached.

[a] Volume XIV, Tenth Census.

Table 14 shows the effect of storage water in Moosehead Lake at three different points below, compared with the estimated flow of the river at the same points without the storage water.

TABLE 14.—*Effect of storage of water in Moosehead Lake on flow at Waterville, North Anson, and The Forks.*[a]

[Flow in second-feet per square mile of drainage area.]

Month.	Waterville (drainage area 4,270 sq. miles).		North Anson (drainage area 2,790 sq. miles).		The Forks (drainage area 1,570 sq. miles).	
	Observed flow.	Estimated flow without storage.	Observed flow.	Estimated flow without storage.	Observed flow.	Estimated flow without storage.
1905.						
January	0.72	0.14	0.95	0.07	.....	.....
February	.62	.34	.74	.32	.....	.....
March	1.23	1.37	1.47	1.68	.....	.....
April	3.16	3.99	3.74	5.01	1.06	3.32
May	2.46	3.07	3.12	4.06	2.76	4.43
June	1.57	1.35	2.52	2.19	3.44	2.85
July	1.09	.71	1.97	1.09	2.59	1.57
August	.75	.32	1.04	.53	1.32	.16
September	.70	.47	.71	.36	.80	.18
October	.41	.21	.43	.12	.55	.01
November	.54	.40	.48	.27	.54	.15
December	.48	.35	.91	.70	.....	.....
1906.						
January	.75	.75	.60	.60	.....	.....
February	.53	.62	.44	.58	.....	.....
March	.54	.54	.44	.44	.....	.....
April	4.02	4.62	2.55	3.44	.....	.....
May	5.22	6.50	4.75	6.71	4.75	8.24
June	2.99	2.84	2.67	2.45	3.65	3.25

[a] H. K. Barrows, Hydrographer, U. S. Geological Survey.

The effect of the forest cover in holding back water is very much the same as that of a great storage reservoir. The forests of any large watershed stretch over thousands of square miles, and their extraordinary power in conserving moisture so as to keep the volume of water in the rivers forever flowing to the sea is such that the imagination can scarcely conceive it. The forest is a conserving force, and prevents alternate floods and periods of low water. Navigation, like water power, is particularly injured by low water. When the necessary depth of water fails, river craft must tie to the banks.

Mr. C. C. Goodrich, manager of the New York and Hartford Transportation Company, who speaks from the point of view of the man engaged in marine commerce, says:

From my earliest business years I have lived upon the Connecticut River. I have managed a navigation company, having 35 vessels, including a line of steamers from Hartford to New York. In my first experience the vast forests on the mountains in New Hampshire region were dense with evergreen. They were damp and cool and full of springs, full of lichen, and full of moss.

The snow lay unmelted in those forests until the last of May and oftentimes into June. We had a steady feed from the melting of this snow far into the summer. The years went by and the lumbering of the first growth commenced. The large timber was swept from this great section, and we thought that with the disappear-

ance of that our suffering, which had been quite severe, had ceased. But within a very short time the paper industry came in. The paper-pulp industry followed, and the smaller timber, which had at this time begun to reclothe the mountains and to replace the old timber, and to give shelter and shade and give a chance for the moisture, began to be taken away. That was followed by forest fires which took away the original great roots that had then become dry, and when these forest fires swept over any portion of the mountains they burned not only all that was on top of the soil, but burned deep into the soil. They destroyed everything beyond the possibility of ever producing a crop again.

When this effect was felt we were obliged to stop our steamers. The steamer leaving Hartford on Sunday evening was obliged to be shifted until Monday evening. The great Holyoke dam, which had always before been full along in June, July, and August, became full by the 1st of May. The vast accumulation of snow had disappeared; it had gone a month earlier. The springs and lichens and moss were all gone, and by the time June, July, and August came there was a great dearth of water.

In those days the flow could not be held by the power companies beyond five hours. At the end of the five hours the flow came along and went over the dam, to aid those who were engaged in marine commerce.

I have had ample opportunity to realize the effect upon our river of the denuding of the forests in the White Mountains, especially of late years, since the cutting has extended to the minor timber, the spruce of 6 or 8, and even 5 inches, which was formerly left to grow. From the beginning of my experience our floods have commenced from about the 1st to the 10th of April, and they came for the next two months pretty steadily, and for two months longer there was still a steady feed from those mountains. In the last twenty years the freshet has come fully one month earlier * * * coming rapidly in the spring, when it was of no use to the mill man or the man engaged in navigation, and escaping and going by without being made valuable in any way, and has been followed at the present time by an almost total lack of flow, beginning with about the 10th of May and extending through until the fall rains come again, nearly to the 1st of October.

It is the opinion of competent engineers that erosion from the mountains assists in filling up the rivers with silt and forms sand bars that obstruct navigation. Erosion is naturally greatest on the steep slopes, where the water gains great power in short space. Mr. A. M. Schoen, Atlanta, Ga., of the American Institute of Electrical Engineers, says:

I was in Augusta recently with the commissioner of waterways, and we examined some of the dirt that was being taken up by his dredge from the bottom of the Savannah River. That soil proved beyond question that it was coming from up about the headwaters of the river. There was nothing in it that was anything like the soil down in that section; and in further talking with this gentleman he told me that he had found there had been more filling in of this stream in the past eighteen months since they had been cutting the timber on the headwaters than there had been previously in thirteen years.

Mr. C. C. Goodrich points out that in the lower Connecticut $10,000 yearly are devoted to the removal of deposits that come from the north, and without the aid of this sum marine commerce would be impossible. He added that as long as rivers run these bars will go on building, but "with the wash of the unprotected mountains and clearing away of these forests, we are getting far more than

our share of New Hampshire, Vermont, and Massachusetts—more than we wish to have placed at that point, for it is certainly a source of very great danger and annoyance to us. Would it not be cheaper to protect the forests and keep the silt where nature first placed it, than to remove it at great expense from the rivers and harbors?" Mr. Goodrich asserts further that the sand constantly forming bars between Hartford and Long Island Sound, and at the mouth of the Connecticut, "is composed of clean, white grit, as hard as diamonds, heavier than the alluvial soil," and that it came down through the forests from the mountains.

HEALTH AND RECREATION.

The fame of the White Mountains as a region of unusual beauty is widespread and of long standing. For purposes of health, rest, and recreation they are sought annually by many thousands of people from all parts of the country, whose return year after year means that they find what they seek. Some of the mountains and streams bear the names of those who have found inspiration from them. Thus Hale Mountain is named for Edward Everett Hale, who has known and visited these mountains since the time when, a young man, he helped survey them more than sixty years ago. Beecher Falls recall the favorite haunts of the long-time pastor of Plymouth Church. Mount Cleveland stands in the town of Bethlehem, although the summer home of the late President is in Tamworth. Near to Mount Cleveland is the cottage of the late Theodore Thomas. The home of the late Augustus St. Gaudens was within the southwestern border of the White Mountain region. Near by, on Sunapee Lake, is the summer home devotedly loved by the late John Hay. Who better have served the public welfare and led the American people, either in letters, in public life, or in finished artistic expression? If these and thousands more who, if less famous, are yet most active leaders of thought and action, sought the inspiration of the White Mountain forests, their verdict should not be set aside as of little weight. The preservation and proper use of the White Mountain forests are essential not only to the economic welfare of a large section, but they also feed directly the higher life, and for this reason alone are worthy of a supreme effort to save them from denudation. The White Mountains have no large private game preserves and are not frequented by very rich persons to the exclusion of the common people. In the great number of hotels and boarding houses throughout the region, thousands of teachers and preachers, business men, salaried men, and wage earners and their families find health and pleasure. For the nearly two thousand men and women who are members of the Appalachian Mountain Club, the White Mountains are the chief interest. The mountains are used by people from

all parts of the country, particularly the Middle West, and there are colonies of summer residents, not only from Boston, Worcester, Providence, and other New England cities, but also from New York, Chicago, Hampton, Va., St. Louis, and Milwaukee, and there is a contingent of regular visitors from Atlanta, Memphis, Peoria, and Kansas City.

In the year 1899 the New Hampshire State Bureau of Labor collected the following statistics of summer business. The increase since that time is probably more than 20 per cent. The figures are for the State as a whole, and considerably more than half of the business is probably in the White Mountains.

TABLE 15.—*General summary of the summer-resort business.*

Capital invested in summer property	$10,442,352
Total wages paid	$539,901
Cash received from railroad fares (estimated)	$600,000
Cash received from stage fares	$63,275
Cash received from steamboat fares on Lakes Winnepesaukee, Asquam, Sunapee, and Newfound	$60,369
Increase in cash received at hotels and farm houses in 1899 over 1898	$402,341
Cash received from the summer people	$4,947,935
Number of different guests remaining one week or longer	58,222
Number of transient guests remaining less than one week	95,706
Number of persons occupying cottages	20,352
Total number guests and in cottages	174,280
Number of towns and cities where guests are taken	204
Number of farm houses where boarders are taken	1,621
Increase in number of guests in 1899 over 1898	8,093
Number of male help employed	3,297
Number of female help employed	9,057
Total number help employed	12,354

A few of the large hotel companies, in order to protect their interests, have acquired tracts of forest land. The sum of these amounts to about 28,000 acres, which are managed primarily for their beauty, and constitute practically a forest reserve of this size. Of this forest land two hotel companies own 10,000 acres each. One tract is located in the broad level valley of the Ammonusuc River, immediately under Mount Washington and the Presidential Range. It has been carefully studied and mapped, and considerable forest planting has been done, both for beauty and for a future forest crop. Some logging, also, has been done in the least conspicuous places. For a time a trained forester was employed to care for the extensive forest nursery, and to oversee the plantations. The tract of the other hotel company is located in the Franconia Notch. Still another large timber tract, containing a very beautiful natural forest park, belongs to a hotel company, in the valley of the Mad River, at Waterville. These afford an excellent beginning in forest preservation.

Many of the attractive forests in the White Mountains belong, however, to the lumber companies, and several of the most attractive ones have been cut over during the last four years.

CONCLUSION.

The lessons of forestry abroad, worked out often from bitter experience, should be taken into account in any effort to protect the forests on a great series of watersheds, such as the White Mountain region. Forests may and should be so managed that they will become profitable and yield permanent revenues; but this occurs usually only after long periods of good management. The great need in the White Mountains is for timely action, since the forest waste now going on can be repaired only at very great cost. Private forest management in the mountains does not, and, in view of the long time element required, can not by itself prevent wasteful forest use. That persistent intelligent management will maintain forests at a high permanent efficiency, even in rough country, is shown in the forests of Japan. In Württemberg the total net revenue annually from government forests is over $3,000,000; in Saxony over $2,000,000; in Prussia $17,000,000; in France nearly $4,000,000, and in Austria more than $5,000,000.

This publication has sought to establish these facts:

(1) The timber supply in the White Mountain region, including spruce, which will last about twenty years, and the hardwoods, which are as yet both abundant and cheap, is of importance not only to New England but also to the country at large. These forests are near to a great population, and the pinch of scarcity in the timber supply is already felt everywhere. As the general population grows rapidly in numbers, the rate of consumption increases, but the supply does not increase correspondingly. On the steep slopes the spruce forests will last only four or five years.

(2) The protection of the mountain forests from fire is of great importance, because fire consumes the soil, rendering it in many places permanently impaired and even barren. This prevents future timber supply and greatly facilitates erosion and rapid run-off of water. Fires have already caused irreparable damage.

(3) The water flowing from the White Mountain forests touches vast manufacturing interests, and it is essential that the flow of the rivers be kept uniform. On some rivers more than others storage of water in the lakes tends to offset the evil effects of forest destruction, but forest conservation is necessary for this lake storage. Taking the problem as a whole, forest preservation over wide areas, and especially on steep slopes, is the only sure dependence. In the long run nature's way is the safe way.

(4) The influence of the mountain forests upon navigation is direct, in the opinion not only of engineers and hydrographers, but also of the business men, who have most to do with marine commerce.

(5) The White Mountains are a source of rest and recreation to the people from many States. Their health is a national asset.

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